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Prevalence and Causes of Vision Impairment and Blindness in Older Adults in Brazil: The São Paulo Eye Study

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Abstract

Purpose—Investigate prevalence and causes of vision impairment/blindness in older adults in a low-middle income area of São Paulo, Brazil.

Methods—Cluster sampling, based on geographically defined census sectors, was used in randomly selecting cross-sectionally persons 50 years of age or older. Subjects were enumerated through a door-to-door survey and invited for measurement of presenting and best-corrected visual acuity and an ocular examination. The principal cause was identified for eyes with presenting visual acuity less than 20/32.

Results—A total of 4,224 eligible persons in 2,870 households were enumerated, and 3,678 (87.1%) examined. The prevalence of presenting visual acuity ≥20/32 in both eyes was 61.6% (95% confidence interval [CI]: 59.4%–63.9%), and 80.4% (95% CI: 78.8%–82.1%) with best correction. The prevalence of visual impairment (<20/63 to ≥20/200) in the better eye was 4.74% (95% CI: 3.97%–5.53%), and 2.00% (95% CI: 1.52%–2.49%) with best correction. The prevalence of presenting bilateral blindness (<20/200) was 1.51% (95% CI: 1.20%–1.82%), and 1.07% (95% CI: 0.79%–1.35%) with best correction. Presenting blindness was associated with older age and lack of schooling. Retinal disorders (35.3%) and cataract (28.3%) were the most common causes of blind eyes. Cataract (33.2%), refractive error (32.3%), and retinal disorders (20.3%) were the main causes of vision impairment <20/63 to ≥20/200, with refractive error (76.8%) and cataract (12.2%) as main causes for eyes with acuity <20/32 to ≥20/63.

Conclusions—Vision impairment is a significant problem in older Brazilians reinforcing the need to implement prevention of blindness programs for elderly people with emphasis on those without schooling.

Keywords

Adults; prevalence; vision impairment; blindness; low-income

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INTRODUCTION

The prevention of blindness and visual impairment is a high priority topic in public health with a continuing need for population-based studies to provide an up-to-date characterization of the magnitude and nature of the blindness problem. Societal changes and medical advances in the last decades have resulted in corresponding changes in the burden of blindness and visual impairment. Progressive urbanization, longer life expectancy, and behavioral changes in many parts of the world have contributed to an increase of newly emergent blindness causes, such as diabetic retinopathy and age-related macular degeneration, and a decrease of classical causes, such as oncocerchiasis, trachoma, and xerophthalmia. Identification of the prevalence and causes of visual impairment and blindness are crucial for the establishment of local programmes and supra-national, continental, and world prevention strategies. This information is of critical importance for both scientists and international agencies working in the field.

Brazil is an example of a country that experienced important social changes in the last decades of the 20th century, with massive urbanization and the implementation of modern medical care radically shifting the public health landscape. Several medical areas had beneficial impact, among them successful programs for HIV infection prevention and a new initiative to improve access to modern cataract surgery.

Since the mid-1990s, the Brazilian government prioritized access to cataract surgery in addressing a leading cause of reversible blindness.[1] This initiative led to streamlined opportunities for rapid access to modern cataract surgery at designated sites throughout the country, with increased government subsidy. As a result, the estimated number of cataract surgeries increased from approximately 100,000 in years prior to 1998 to 320,000 in 2002.[2] The potential impact of this policy on visual impairment/blindness in a representative low-middle income area of São Paulo was an underlying motivation for this population-based survey.

This article reports on the prevalence and causes of distance visual acuity impairment and blindness among those 50 years of age or older in three representative districts of São Paulo City. A subsequent article will deal with the prevalence of cataract surgery and visual acuity outcomes.

MATERIALS AND METHODS

Ermelino Matarazzo, Vila Jacuí, and São Miguel, 3 of 96 administrative districts in the eastern part of the metropolitan São Paulo area, were chosen for the survey, following the protocol and clinical methods used for similar previous studies in Nepal, China, and India.[3–8] The three districts are composed of 462 census sectors with a 2000 Census population of 346,170.[9] Those 50 years or older comprise 13.8% of the population with 44.7% of these males. São Paulo City as a whole has a population of 10,434,252 with 17.5% aged 50 years or older. Literacy is 89.8% in the three districts, compared with 92.0% in São Paulo City. A total of 49.6% of households have income of three times the minimum wage level (approximately 400 US dollars/month) or less compared with 40.1% in São Paulo City. (The original study plan was to include middle-high income districts of São Paulo in the survey, but because of a very poor response during the pilot phase of the project, the study area was redefined to include only low-middle SES districts.)

Eye care in the three districts is available in three primary health care centers, and in two public hospitals with ophthalmology outpatient clinics. One of these is the Hospital Municipal de Ermelino Matarazzo (HMEM), where the clinic was recently established as a tertiary ophthalmic division of the Vision Institute of Federal University of São Paulo (UNIFESP). (The three study districts were chosen in part because of their proximity to HMEM.)

The study population was selected through cluster sampling of the three districts based on 2000 Census data. In defining sampling frame clusters, census sectors with fewer than 135 persons 50 years or older were grouped with an adjacent sector and sectors with more than 270 persons 50 years or older were segmented, producing 256 clusters with 135 to 270 persons 50 years or older.

Sample size requirements were calculated on the basis of estimating an expected blindness prevalence of 4% within an error bound (precision) of 20% with 95% confidence interval.[3–5, 8] Assuming an examination response rate of 85%, and a design effect of 1.5 to account for the cluster sampling design, a sample size of 4,068 persons 50 years or older was required. Accordingly, 22 clusters, consisting of 34 census sectors, were randomly selected with equal probability from the 256 sampling units. This resulted in a total 2000 Census population of 29,066 with an estimated 4,053 persons 50 years or older.

Study field work was carried out over a 16-month period, beginning in late July 2004. After mapping households within the selected clusters, all residents 50 years or older were enumerated (name, gender, age, ethnicity, education, household income, spectacle use) in a door-to-door survey by three enumeration teams; each team consisted of 3–5 field workers including one supervisor. *Residency* was defined as having lived in the area for at least the last 6 months, including those who may have been temporarily absent at the time of the enumeration.

Within each cluster, enumerated persons were invited to the clinical examination station at the nearby HMEM on a mutually agreed-upon date. Written informed consent was obtained at the examination station using a scripted consent form. The clinical team consisted of one supervising ophthalmologist, four ophthalmologist examiners, and six ophthalmic technologists. Ophthalmologists had at least 5 years of specialty experience, and all ophthalmic technologists had a minimum of 2 years of experience.

The ophthalmic technologist measured presenting distance visual acuity using a retro-illuminated LogMAR tumbling E chart at 4 metres, and at 1 metre for those failing to read the top line (<20/200). Testing for counting fingers, hand movement, and light perception was performed on those unable to read the top line at 1 metre. Each eye was measured separately, with glasses if worn. Visual acuity was recorded as the smallest line read with one or no errors.

All participants with presenting visual acuity 20/40 or worse, in either eye, and all cataract-operated individuals, irrespective of presenting vision, were refracted by an ophthalmologist to achieve the best visual acuity.

Ophthalmic examination of the eyelid, globe, pupillary reflex, and lens was carried out by an ophthalmologist. Intraocular pressure was measured by applanation tonometry on an optional basis to exclude glaucoma as determined by the examiner. For aphakic/pseudophakic participants, surgical history and clinical details pertaining to the type of surgery and signs of surgical complications were noted. Participants with best-corrected distance vision 20/40 or worse had their pupils dilated for indirect ophthalmoscopy and slit lamp examination. Additionally, those suspected to have cataract, open angle glaucoma, and retinal or disc abnormalities, regardless of vision status, were dilated as determined by the examiner.

Eyes with presenting visual acuity 20/40 or worse were assigned a *principal* cause of visual impairment/blindness by the examining ophthalmologist using a 14-item list. Refractive error was assigned as the cause for those eyes where distance visual acuity improved to 20/32 or better with refractive correction. Cataract was assigned when lens opacity commensurate with visual acuity was present, and glaucoma was assigned when elevated intra ocular pressure (IOP) was accompanied by glaucomatous disc changes.

Treatment of minor eye ailments was provided at the examination site free of charge for the patients as well as spectacles if needed. Those requiring cataract surgery were referred to the HMEM for free services.

Subjects failing to come to the hospital examination station after repeated contact were invited for examination at a community centre near their home. The physically disabled and those failing to come to the community centre were offered an ocular examination (using portable equipment) at their home. Visual acuity was measured in these subjects with the LogMAR chart in daylight.

Survey field work was preceded by 2 days of staff training at UNIFESP. This was followed by a pilot field exercise (full-dress rehearsal) outside of the study area.

This study adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all participants after explanation of the nature of the study and possible consequences of the examination. The Committee on Ethics on Research of UNIFESP approved the implementation of the survey protocol. Human subject research approval of the original protocol was cleared by the World Health Organization Secretariat Committee on Research Involving Human Subjects.

Data management and analysis

Household enumeration and clinical examination data forms were reviewed in the field for accuracy and completeness before being transferred to UNIFESP for computer data entry. Measurement data ranges, frequency distributions, and consistency among related measurements were checked with data cleaning programs.

For analysis of vision status, visual acuity in eyes was categorized as normal vision, ≥20/32; near normal vision <20/32 to ≥20/63; visual impairment <20/63 to ≥20/200; moderate blindness <20/200 to ≥20/400; and severe blindness <20/400. Consistent with the previous studies in Nepal, China, and India, bilateral vision was categorized as (1) NN: normal or near normal vision, ≥20/63 in both eyes; (2) VI: unilateral visual impairment, <20/63 to ≥20/200 in the worse-seeing eye and ≥20/63 in the better-seeing eye; bilateral visual impairment, <20/63 to ≥20/200 in both eyes; (3) UL: unilateral blindness, <20/200 in the worse-seeing eye and ≥20/200 in the better-seeing eye; (4) MB: moderate bilateral blindness, <20/200 in the worse-seeing eye and <20/200 to ≥20/400 in the better-seeing eye; (5) SB: severe bilateral blindness, <20/400 in both eyes (corresponding to the WHO definition of *blindness*).

Prevalence rates of visual impairment/blindness using presenting and best-corrected visual acuity were calculated. Multiple logistic regression was used to investigate the association of presenting and best-corrected bilateral blindness with age (using 10-year intervals), gender, education (using graduation levels), and household income (using minimum wage levels).

The cause of visual impairment and blindness was analysed with respect to both individual eyes and persons. Those with visual impairment/blindness in both eyes may represent two different causes of reduced vision. For example, a person bilaterally blind with cataract as the cause in one eye and glaucoma as the cause in the fellow eye would represent both cataract blindness and glaucoma blindness when data are reported on a person level.

Statistical analyses were performed using Stata Statistical Software, Release 8.0.[10] Confidence intervals (CI) and p values (significant at the $p < 0.05$ level) were calculated with adjustment for clustering effects associated with the sampling design. Cluster design effects, represented by a ratio (termed, deff), which compares the estimate of variance actually obtained with the generally smaller variance that would have been obtained at simple random sampling being used, are reported. Pairwise interactions between regression model variables were assessed simultaneously using a Wald F test and considered significant at the $p < 0.10$ level.

RESULTS

A total of 6,010 houses were visited in the three districts. Two thousand eight hundred seventy households had at least one eligible study person 50 years or older: 1,623 households (56.6%) had one, 1152 (40.1%) had two, and 95 (3.3%) had three or more eligible persons. A total of 4,224 persons aged ≥50 years were enumerated (Table 1). The mean age of enumerated men was 61.3 years and 62.0 years for women.

A total of 3,678 persons (87.1%) were examined (Table 1). Across the 22 study clusters, examination response rates ranged from 80.3% to 92.2%. The mean age of examined men was 61.8 years and 62.1 years for women. Two thousand seven hundred and twenty (74.0%) of those examined underwent the ophthalmic examination at the hospital outpatient clinic, 792 (21.5%) were examined at the community center, and 166 (4.5%) had in-home examinations.

In logistic regression modeling with age (as a categorical variable) and education as covariates, examination response was associated with older age (odds ratio [OR], 1.35; 95% confidence interval (CI): 1.11%–1.64%) and lower education (OR, 1.18; 95% CI: 1.07%–1.30%) in males, and lower education in females (OR, 1.17; 95% CI: 1.05–1.31). Males and females were modeled separately because of significant covariate interactions when gender was included as a covariate. (With gender included, the higher examination response in females was significant.) Income was not significant when included as a covariate in any of the models.

Visual acuity could not be measured in 36 of the 3,678 examined individuals because of an inability to respond as a result of stroke or other disability. Of the 3,642 with visual acuity measurements, 1,862 (51.1%) were wearing glasses for distance correction, and among these, 1,564 (84.0%) presented with normal/near normal vision.

Table 2 shows the distribution of presenting and best-corrected visual acuity in both the better-seeing eye and the worse-seeing eye. The distribution across the five bilateral vision categories is also shown. Presenting normal or near-normal vision (≥20/63) in both eyes (NN) was found in 80.7% (95% CI: 79.0%–82.4%; deff = 1.483) of participants; visual impairment (<20/63 to ≥20/200) in one or both eyes (VI) in 11.3 (95% CI: 10.2%–12.4%; deff = 1.075); and unilateral blindness (<20/200) in 6.48% (95% CI: 5.44%–7.52%; deff = 1.502). Bilateral blindness (<20/200) was present in 1.51% (95% CI: 1.20%–1.82%; deff = 0.558) of participants: 0.74% (95% CI: 0.53%–0.95%; deff = 0.490) with moderated blindness (MB) and 0.77% (95% CI: 0.51%–1.03%; deff = 0.731) with severe blindness (SB).

The difference between males and females in the distribution of presenting vision across the five bilateral vision categories was not statistically significant (Kolmogorov–Smirnov test; p = 0.587). The distribution across vision categories was also not significantly different between those examined at the community center versus the hospital, between those examined in the home versus the hospital, or between those examined in the home versus the community centre (Kolmogorov–Smirnov test; p = 1.000, p = 0.944, and p = 0.793, respectively).

With best correction, normal/near-normal vision (NN) was increased to 88.2% (95% CI: 87.1%–89.4%; deff = 1.047); unilateral/bilateral visual impairment (VI) was reduced to 5.44% (95% CI: 4.63%–6.24%; deff = 1.070); and unilateral blindness (UL) was 5.27% (95% CI: 4.44%–6.10%; deff = 1.151). Best-corrected bilateral blindness was found in 1.07% (95% CI: 0.79%–1.35%; deff = 0.611) of participants: moderate bilateral blindness (MB) was 0.52% (95% CI: 0.34%–0.70%; deff = 0.539); and severe bilateral blindness (SB) was 0.55% (95% CI: 0.29–0.81; deff = 1.055).

In multiple logistic regression modeling, blindness was associated with older age and lack of education for both presenting and best-corrected vision (Table 3). Gender was not significant. (An odds ratio of less than 1.0 for blindness among females compared with males, in spite of the higher prevalence of blindness in females, is explained by differences in education level: among females, 19.3% are without education compared with 11.6% in males.) Household income was not a significant factor when included as a covariate in either model.

Table 4 shows the distribution and prevalence of causes of unilateral and bilateral blindness on a per-person basis. The causes of blindness were not always the same in the two eyes of bilaterally blind persons; thus, the total for the cause-specific prevalence exceeds the overall (any cause) 1.51% prevalence of bilateral blindness. Cataract (26.7%), other retinal disorders (24.6%), and amblyopia (11.0%) were the most common causes of unilateral blindness. For those with bilateral blindness, cataract (40.0%), glaucoma (20.0%), diabetic retinopathy (16.4%), and macular degeneration (16.4%) were common causes. When retinal disorders are grouped together, they represent the most common cause of both unilateral and bilateral blindness: 80 persons blind unilaterally from retinal causes and another 25 blind bilaterally with a retinal disorder the cause in one or both eyes. The prevalence of unilateral or bilateral blindness caused by retinal disorders is 2.89% (105/3642).

For the 2193 eyes presenting with less than normal visual acuity, Table 5 shows the causes stratified by visual acuity category and age (50–59 years and ≥60 years). Refractive error was the overwhelming cause for visual acuity in the near-normal category (76.8%), with cataract also a notable cause (12.2%) affecting primarily the older age group. For the visual impairment category, cataract (33.2%) and refractive error (32.2%) were the main causes—refractive error in the younger age group and cataract in the older age group—with retinal disorders taken as a whole accounting for 20.3%. For blind eyes, retinal disorders (35.3%) were the main cause in both the younger (42.7%) and older (37.0%) age groups, with cataract (28.3%) the second most common cause for both age groups. Refractive error accounted for 3.8% of blind eyes.

For eyes with near-normal vision, the other causes category includes aphakia, chronic exposure keratitis by facial palsy, postoperative astigmatism, tilted intra-ocular lens (IOL), and recent postoperative phacoemulsification cataract surgery with IOL implant. For visual impairment, other causes were corneal edema, keratitis, keratoconus, and subluxated IOL. For blind eyes, other causes were opacified IOL, corneal edema, large angle restrictive esotropia, and keratoconus. Cause was recorded as undetermined for cases with unexplained visual loss, some requiring further diagnostic investigation.

Table 6 presents data on causes for the subset of 2081 eyes where information on participant education level was available. Refractive error was the main cause of near-normal vision for both participants with and without education. For the visual impairment category, however, cataract was the main cause for those with no education, while refractive error remained as the main cause among participants with education. Similarly, cataract was the main cause of blindness in those with no education, whereas retinal disorders were the most common cause among those with education. (If cataract were removed as a cause of less than normal vision, other differences between those with and without education would remain.) Amblyopia was less common, and macular degeneration more common, among those with no education across all three visual acuity categories. Glaucoma was also relatively more common as a cause of blindness among those with no education.

DISCUSSION

Strengths of the survey were the large, randomly selected sample of enumerated and examined persons. With extensive follow-up visits to absent or hesitant households, the enumeration period extended far beyond what was initially envisioned. Because of safety concerns all of the enumeration visits took place during daylight hours. Upon completion, the number of enumerated subjects actually exceeded the number expected on the basis of the 2000 Census. (It is important to note that the original study plan included surveying high- and middle-income areas of São Paulo. However, based on a very poor response in obtaining access to high SES households during the pilot phase of the project, the study area was redefined to include only low-midle SES districts.)

The high examination response rate (87%) was achieved by repeatedly visiting some households to seek participation—in one instance 18 times—and by offering examinations in three different settings. Reaching resistant cases was important in providing a representative demographic and visual acuity profile of the study population.

Blindness was shown to be associated not only with older age, as expected, but also with the lack of formal education. This is generally consistent with the finding of a higher age-adjusted risk of blindness in the illiterate found in the other studies with a similar examination protocol.[3–8] Blindness was not associated with female gender, as found in some studies.[3, 5, 7] (It should be noted that because examination response rates were also associated with older age and lower education, the prevalence of blindness reported for the study population is likely to have an upward bias.)

Retinal disorders (including diabetic retinopathy, macular degeneration, retinal detachment, and other retinal causes) were the main cause of blindness, followed by cataract and glaucoma. (Visual impairment and blindness because of glaucoma and peripheral retinal diseases could have been underestimated because perimetry was not included in the ocular examination.) One explanation for the relatively high ranking of retinal disorders as a cause of blindness is the success of the Brazilian initiative to improve access to cataract surgical services. With a more than tripling of the annual number of cataract surgeries over the past 5-year period (data not shown), cataract blindness is likely to have been significantly reduced, and therefore, blindness due to other ocular diseases/conditions becoming more prominent. (When diabetic retinopathy and macular degeneration are considered as separate causes, cataract ranks as the main cause of blindness.)

The prevalence of unilateral and bilateral blindness due to retinal disorders was 2.89%. This is remarkably higher than what was found in both Shunyi[4] and Doumen[5] counties in China (0.92% and 0.56% of examined eyes, respectively) and in Rajasthan[6] and Tirunelveli[7] in India (0.75% and 0.66% of examined eyes, respectively), but comparable to the 2.70% prevalence of unilateral or bilateral blindness due to retinal disorders in Hong Kong.[8]

In going beyond the protocol used in the Nepal, China, and India surveys, this study explicitly included visual acuity <20/32 to ≥20/63 as a category of reduced vision (labeled near-normal vision). Including this mild impairment category was considered important in densely populated urban areas such as São Paulo, where visual requirements for driving and work purposes may be more demanding. Our finding of uncorrected refractive error as the primary cause of mild visual impairment is unmistakable.

If a <20/63 cut-point had been used in defining visual impairment, as in the previous surveys where visually impaired/blind eyes improving to 20/63 or better with best correction were classified as refractive error cases, the distribution of causes of impairment for the <20/63 to ≤20/200 visual acuity category would have changed: refractive error would have increased from 32.3% to 61.9%, cataract would have decreased from 33.2% to 17.8%, and retinal disorders would have decreased from 20.3% to 12.3%. For visual acuity <20/200 (blind eyes), refractive error as a cause would have increased from 3.8% to 8.1%, cataract would have decreased from 28.3% to 26.3%, and retinal disorders would have decreased from 35.3% to 34.7%.

Previous studies of adults 50 years of age and older in Latin America conducted in Paraguay, Peru, Venezuela, and Argentina focused on evaluating blindness due to cataract using the rapid assessment of cataract surgical services (RACSS) protocol.[11−14] The RACSS protocol is substantially different from ours in that it uses an abbreviated home-based measurement of presenting visual acuity and a simplified ophthalmic assessment with an emphasis on identifying visual impairment/blindness caused by cataract. The RACSS survey in urban/rural Paraguay found significantly higher prevalence for severe blindness (3.5%), moderate blindness (5.9%), and visual impairment (15.5%).[11] Similarly, the prevalence found in semirural Peru was higher: severe blindness (2.6%), moderate blindness (7.4%), and visual impairment (14.3%).[12] The RACSS survey conducted in urban/rural Venzuela also reported a higher prevalence for moderate and severe blindness combined (3.53%).[13] The RACSS survey in Argentina (Buenos Aires) found a comparable presenting prevalence of severe blindness (0.9%), but a higher prevalence for moderate blindness (2.3%) and visual impairment (6.8%).[14]

The prevalence of visual impairment and blindness based on best-corrected visual acuity puts São Paulo in a position somewhat similar to that in the United States, where the prevalence of best-corrected visual acuity of <20/40 to >20/200 in the better-seeing eye was reported as 1.98% among those 40 years of age, and the prevalence of blindness ≤20/200 as 0.78%.[15]

Because Brazil covers large territory with many socioeconomic and regional discrepancies, additional surveys including rural areas with poor access to eye care are needed to provide more widely representative estimates of visual impairment and blindness in Brazil.

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Table 1

Enumerated and examined population by age, gender, years of schooling, and household income

	Enumerated No. (%)	Examined No. (%)	Percent examined
Age (yrs.)			
50–59	2052 (48.6)	1747 (47.5)	85.1
60–69	1272 (30.1)	1129 (30.7)	88.8
>70	900 (21.3)	802 (21.8)	89.1
Gender			
Male	1834 (43.4)	1542 (41.9)	84.1
Female	2390 (56.6)	2136 (58.1)	89.4
Education level			
No education	639 (15.1)	574 (15.6)	89.8
< Primary	796 (18.8)	706 (19.2)	88.7
Primary	1449 (34.3)	1293 (35.2)	89.2
Middle school	562 (13.3)	488 (13.3)	86.8
High school	423 (10.0)	346 (9.4)	81.8
College or more	147 (3.5)	111 (3.0)	75.5
No information	208 (4.9)	160 (4.4)	76.9
Household Income (R$) *			
None	121 (2.9)	100 (2.7)	82.6
Low	2119 (50.2)	1937 (52.7)	91.4
Average	698 (16.5)	606 (16.5)	86.8
High	31 (0.7)	24 (0.7)	77.4
No information	1255 (29.7)	1011 (27.5)	80.6
All	4224 100.0	3678 100.0	87.1

* Income was categorized using minimum wage (MW) as low (up to 4 MW), average (4–16.5 MW), and high (16.5–33 MW); R$ = Brazilian Real.

Table 2

The distribution of presenting and best-corrected visual acuity*

	Better Eye VA					
Worse eye VA	**>20/32**	**<20/32 to ≥20/63**	**<20/63 to ≥20/200**	**<20/200 to ≥20/400**	**<20/400**	**All**
	Normal/near normal vision (NN)					
≥20/32	2,245 (61.6)					2,245 (61.6; 59.4–63.9)
	2,929 (80.4)					2,929 (80.4; 78.8–82.1)
<20/32 to ≥20/63	374 (10.3)	320 (8.8)				694 (19.1; 17.5–20.6)
	182 (5.0)	102 (2.8)				284 (7.8; 6.8–8.8)
	Unilateral or bilateral vision impairment (VI)					
<20/63 to ≥20/200	120 (3.3)	169 (4.6)	123 (3.4)			412 (11.3; 10.2–12.4)
	96 (2.6)	62 (1.7)	40 (1.1)			198 (5.4; 4.6–6.2)
	Unilateral blindness (UL)			Moderate blindness (MB)		
<20/200 to >20/400	23 (0.6)	25 (0.7)	21 (0.6)	11 (0.3)		80 (2.2; 1.7–2.7)
	25 (0.7)	11 (0.3)	10 (0.3)	10 (0.3)		56 (1.5; 1.1–1.9)
					Severe blindness (SB)	
<20/400	84 (2.3)	54 (1.5)	29 (0.8)	16 (0.4)	28 (0.8)	211 (5.8; 5.0–6.6)
	101 (2.8)	22 (0.6)	23 (0.6)	9 (0.2)	20 (0.5)	175 (4.8; 4.0–5.6)
All	2,846 (78.1; 76.6–79.8)	568 (15.6; 14.2–17.0)	173 (4.8; 4.0–5.5)	27 (0.7; 0.5–0.9)	28 (0.8; 0.5–1.0)	3,642 (100.0)
	3,333 (91.5; 90.5–92.6)	197 (5.4; 4.6–6.3)	73 (2.0; 1.5–2.5)	19 (0.5; 0.3–0.7)	20 (0.5; 0.3–0.8)	3,642 (100.0)

*Data are given as numbers of persons (prevalence percentage; 95% confidence interval). For each pair of numbers presenting visual acuity is on the top and best-corrected visual acuity on the bottom.

Table 3

Prevalence of bilateral blindness (<20/200) in persons by age, gender and education

		Presenting blindness		Best-corrected blindness	
	Number Examined*	Prevalence No. (%)	Adjusted odds ratio (95% confidence interval)	Prevalence No. (%)	Adjusted odds ratio (95% confidence interval)
Age (yrs.)					
50–59	1739	11 (0.63)	Reference	8 (0.46)	Reference
60–69	1124	13 (1.16)	1.50 (0.53–4.25)	9 (0.80)	1.23 (0.38–3.96)
>70	779	31 (3.98)	4.13 (2.14–7.94)‡	22 (2.82)	3.58 (1.58–8.08)†
Gender					
Male	1527	21 (1.38)	Reference	16 (1.05)	Reference
Female	2115	34 (1.61)	0.91 (0.50–1.66)	23 (1.09)	0.85 (0.41–1.79)
Education level					
No education	560	27 (4.82)	Reference	20 (3.57)	Reference
< Primary	698	5 (0.72)	0.25 (0.16–0.39)‡§	2 (0.29)	0.23 (0.13–0.42)‡§
Primary	1285	13 (1.01)		11 (0.86)	
Middle school	486	4 (0.82)		3 (0.62)	
High school	345	2 (0.58)		1 (0.29)	
College or more	111	0 (0.00)		0 (0.00)	
No information	157	4 (2.55)		2 (1.27)	
All	3642	55 (1.51)		39 (1.07)	

*The multiple logistic regression odds ratios are based on the 3,485 participants with information on education level (and not the entire 3642 examined).

†$p < 0.01$.

‡$p < 0.001$.

§Represents any education.

Table 4

Principal causes and prevalence of presenting blindness (<20/200)

	Unilaterally blind persons		Bilaterally blind persons	
Principal cause	**Persons No. (%)**	**Prevalence (%)**	**Persons* No. (%)**	**Prevalence* (%)**
Retinal disorders	80 (33.9)	2.20	26 (47.3)	0.71
Diabetic retinopathy	12(5.1)	0.33	9 (16.4)	0.25
Macular degeneration	5(2.1)	0.14	9 (16.4)	0.25
Other retinal disorders	58 (24.6)	1.59	7(12.7)	0.19
Retinal detachment	5(2.1)	0.14	1 (1.8)	0.03
Cataract	63 (26.7)	1.73	22 (40.0)	0.60
Glaucoma	11 (4.7)	0.30	11 (20.0)	0.30
Absent/disorganized globe	12(5.1)	0.33	5(9.1)	0.14
Refractive error†	8 (3.4)	0.22	3 (5.5)	0.08
Other optic atrophy	10 (4.2)	0.27	1 (1.8)	0.03
Amblyopia	26 (11.0)	0.71	0 (0.0)	0.00
Corneal opacity/scar	20 (8.5)	0.55	0 (0.0)	0.00
Other causes	3(1.3)	0.08	1 (1.8)	0.03
Undetermined	3(1.3)	0.08	3 (5.5)	0.08
All (any cause)	236 (100.0)	6.48	55 (100.0)	1.51

*The totals for the cause specific prevalence exceed the “ALL (any cause)” prevalence because a person can represent two different causes of blindness.

†Includes only cases improving to >20/32 with subjective refraction.

Table 5

Principal causes of visual acuity <20/32 in eyes by participant age

	Normal/near normal vision <20/32 to ≥20/63		Vision impairment <20/63 to ≥20/200		Blindness <20/200	
Principal cause	**50–59 years (*n* = 393)**	**>60 years (*n* = 869)**	**50–59 years (*n* = 138)**	**>60 years (*n* = 447)**	**50–59 years (*n* = 89)**	**>60 years (*n* = 257)**
Refractive error*	353 (89.8)	616 (70.9)	73 (52.9)	116 (26.0)	4 (4.5)	9 (3.5)
Retinal disorders	14 (3.6)	59 (6.8)	24 (17.4)	95 (21.3)	34 (38.2)	88 (34.2)
Other retinal disorders	11 (2.8)	16 (1.8)	15 (10.9)	46 (10.3)	25 (28.1)	43 (16.7)
Diabetic retinopathy	3 (0.8)	18 (2.1)	9 (0.7)	27 (6.0)	9 (10.1)	18 (7.0)
Macular degeneration	0 (0.0)	25 (2.9)	0 (0.0)	22 (4.9)	0 (0.0)	21 (8.2)
Retinal detachment	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	6 (2.3)
Cataract	8 (2.0)	146 (16.8)	10 (7.2)	184 (41.2)	16 (18.0)	82 (31.9)
Amblyopia	5(1.3)	13 (1.5)	20 (14.5)	16 (3.6)	11 (12.4)	15 (5.8)
Glaucoma	4(1.0)	6 (0.7)	1 (0.7)	9 (2.0)	7 (7.9)	21 (8.2)
Corneal opacity/scar	3 (0.8)	3 (0.3)	0 (0.0)	12 (2.7)	4 (4.5)	16 (6.2)
Absent/disorganized globe	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	8 (9.0)	9 (3.5)
Other optic atrophy	1 (0.3)	0 (0.0)	0 (0.0)	4 (0.9)	4 (4.5)	7 (2.7)
Posterior capsule opacification	0 (0.0)	8 (0.9)	2(1.4)	3 (0.7)	0 (0.0)	0 (0.0)
Other causes	1 (0.3)	4 (0.5)	1 (0.7)	4 (0.9)	1 (1.1)	3(1.2)
Undetermined	4(1.0)	14 (1.6)	7(5.1)	4 (0.9)	0 (0.0)	7 (2.7)

*Includes only eyes improving to ≥20/32 with subjective refraction.

Table 6

Principal causes of visual acuity <20/32 by participant education status

	Normal/near normal vision <20/32 to >20/63		Vision impairment <20/63 to >20/200		Blindness <20/200	
Principal cause	**No education (*n* = 322)**	**Education (*n* = 883)**	**No education (*n* = 155)**	**Education (*n* = 397)**	**No education (*n* = 104)**	**Education (*n* = 220)**
Refractive error*	217 (67.4)	710 (80.4)	34 (21.9)	140 (35.3)	2(1.9)	11 (5.0)
Retinal diseases	22 (6.8)	49 (5.5)	28 (18.1)	86 (21.7)	32 (30.8)	87 (39.6)
Other retinal disorders	6(1.9)	21 (2.4)	12(7.7)	47 (11.8)	15 (14.4)	51 (23.2)
Diabetic retinopathy	8 (2.5)	13 (1.5)	7 (4.5)	29 (7.3)	7 (6.7)	19 (8.6)
Macular degeneration	8 (2.5)	15(1.7)	9 (5.8)	10 (2.5)	9 (8.7)	12 (5.5)
Retinal detachment	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.0)	5 (2.3)
Cataract	61 (18.9)	83 (9.4)	79 (51.0)	105 (26.4)	46 (44.2)	41 (18.6)
Amblyopia	3 (0.9)	14 (1.6)	4 (2.6)	31 (7.8)	0 (0.0)	24 (10.9)
Glaucoma	3 (0.9)	7 (0.8)	2(1.3)	8 (2.0)	10 (9.6)	14 (6.4)
Corneal opacity/scar	2 (0.6)	4 (0.5)	1 (0.6)	10 (2.5)	5 (4.8)	14 (6.4)
Absent/disorganized globe	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2(1.9)	14 (6.4)
Other optic atrophy	0 (0.0)	1 (0.1)	0 (0.0)	4(1.0)	3 (2.9)	8 (3.6)
Posterior capsule opacification	4(1.2)	3 (0.3)	2(1.3)	3 (0.8)	0 (0.0)	0 (0.0)
Other causes	1 (0.3)	4 (0.5)	1 (0.6)	4(1.0)	1 (1.0)	3(1.4)
Undetermined	9 (2.8)	8 (0.9)	4 (2.6)	6(1.5)	3 (2.9)	4(1.8)

*Includes only eyes improving to ≥20/32 with subjective refraction.